Cruise Ship Emissions and Control in Hong Kong

March 2013
Simon Ng
About Civic Exchange

Civic Exchange is a Hong Kong-based non-profit public policy think tank that was established in October 2000. It is an independent organisation that has access to policy-makers, officials, businesses, media and NGOs – reaching across sectors and borders. Civic Exchange has solid research experience in areas such as air quality, energy, urban planning, climate change, conservation, water, governance, political development, equal opportunities, poverty and gender. For more information about Civic Exchange, visit: www.civic-exchange.org.

About the Author

Simon Ng is Head of Transport and Sustainability Research of Civic Exchange. His major research interests include sustainable transportation, liveable cities, air quality management, and local community planning. Simon is known for his work on ship emissions inventory and control policy in Hong Kong and the Pearl River Delta. He is also actively sharing his experience and expertise with policy makers and practitioners in other parts of the world, including Los Angeles, Shanghai and Guangdong.
Preface & acknowledgements

In addition to the incentive scheme introduced by the HKSAR Government last September, the Chief Executive CY Leung announced in his January 2013 Policy Address that the Government would make at-berth fuel switching in Hong Kong for ocean-going vessels compulsory through legislation. This represents a major policy move in ship emissions control in Hong Kong.

While Hong Kong has officially set its path towards ship emissions control, it needs to take into account the likely impacts of the opening of the new Kai Tak Cruise Terminal in June 2013. The Hong Kong’s cruise market will surely enter a new phase of development as the expected increase in calls and longer berthing time of vessels will mean more business opportunities and economic benefits for Hong Kong. However, cruise ship emissions and their impacts on the environment as well as public health also deserve our attention.

Civic Exchange has developed its interests in shipping and port-related emissions research since 2005. This short paper is Civic Exchange’s first attempt to look into cruise ship emissions. Through this paper, we hope to provide the latest information about cruise ship emissions in Hong Kong and to explore potential options for emissions control. We also hope this paper can stimulate and facilitate the discussion on the ways in which cruise ships can minimise their emissions, and thereby reduce their impacts on public health and the environment, while the cruise industry continues to thrive economically.

I would like to thank Simon Ng for taking up this research and Bryan Suen for collecting data. We would also like to thank Arthur Bowring, Jeff Bent, Barbara Finamore, Rich Kassel, Diane Bailey, David Pettit, and Jake Schmidt for sharing their insights. We are grateful to ADM Capital Foundation for sponsoring this research. We thank Michelle Wong for designing this paper, and Cissy Lui for translating it.

Yan-yan Yip
Chief Executive Officer
March 2013
Introduction

1.1 Ship emissions in Hong Kong

In 2010, all marine vessels emitted 16,900 tonnes of sulphur dioxide (SO₂), 35,000 tonnes of nitrogen oxides (NOₓ) and 2,260 tonnes of particulate matter (PM₁₀) in Hong Kong. In terms of relative contribution amongst major air pollution sources, marine vessels were the second largest emitter of SO₂ (48%) after power plants, and the largest emitter of both NOₓ (32%) and PM₁₀ (36%).¹ Recently, the Hong Kong Special Administrative Region (HKSAR) Government indicated that marine vessels had become the largest source of all three air pollutants above in 2011², but the actual numbers have not yet been released.

Ocean-going vessels contribute most

According to a study on marine vessels emission inventory in Hong Kong commissioned by the Environmental Protection Department³, ocean-going vessels (OGVs) contributed the most emissions, compared to river vessels and local vessels. For example, 79% of SO₂ and 68% of PM₁₀ were emitted from OGVs. For NOₓ, OGVs contributed about 44%.

Container vessels and cruise ships are main emitters

Among different types of OGVs, container vessels accounted for 80% of SO₂, 79% NOₓ and 81% PM₁₀. They were the main emitter of air pollutants. In second place, cruise ships contributed 9% of SO₂, 11% of NOₓ and 9% of PM₁₀.⁴

At-berth emissions significant, but offer opportunities to clean up

It is also highlighted in the same study that 42% of SO₂, 32% of NOₓ and 33% of PM₁₀ were emitted at-berth by OGVs.⁵ In Hong Kong, major berthing locations for OGVs include Kwai Chung Container Terminals, Ocean Terminal, oil terminals on Tsing Yi Island, gas and coal receiving terminals, and cargo handling berths. There are also cargo vessels that operate at mid-stream locations, as well as cruise ships that moor mid-stream at government buoys in Victoria Harbour.

Ship emissions are classified as carcinogenic by WHO

Marine diesel engines are one of the main sources of air pollution. Last year, the International Agency for Research on Cancer of the World Health Organization re-classified diesel engine exhaust as probably carcinogenic to humans (Group 2A) to carcinogenic to humans (Group 1).⁶ As some of the berthing locations listed above where a significant portion of ship emissions are produced are also close to Hong Kong’s population centres and business districts, people are understandably concerned about ship emissions and their negative health impact. It is a pressing issue that requires swift action from all sectors in society.
1.2 Voluntary actions and government regulation

In response to the call to reduce emissions, the shipping industry took the lead and launched the Fair Winds Charter (FWC) for two years from 1 January 2011 to 31 December 2012. Initially, 17 major shipping companies signed up for FWC, which was later increased to 19, and the signatories voluntarily committed their vessels to switch to low sulphur fuel with sulphur content of not more than 0.5% while at berth in Hong Kong at their own cost. In January 2013, 17 shipping companies agreed to extend FWC for another year until the end of 2013.

FWC has brought along significant emission reduction benefits to Hong Kong. As an example, it is estimated that 890 tonnes of SO₂ were reduced in 2011 by the voluntary fuel switch. In addition, FWC signatories also call for regulation on ship emissions in Hong Kong and across the Pearl River Delta region, consistent with international standards.

In September 2012, the Government responded to the industry’s initiative by introducing an incentive scheme. Ocean-going vessels using cleaner fuel with sulphur content of 0.5% or less while berthing in Hong Kong waters will receive a 50% reduction in port facility and light dues. According to the industry, it will roughly recover 40% of the additional cost for fuel switching per call.

In his maiden policy address this year, Chief Executive CY Leung announced the Government’s decision to legislate the requirement of at-berth fuel switching in Hong Kong for OGVs. This is a major policy breakthrough in ship emissions control in Hong Kong. Consultations with the industry are underway, and the plan is to submit a proposal to the next legislative session for consideration. The Government is also exploring with the Guangdong Provincial Government about region-wide regulations on at-berth fuel switching.

With respect to cruise ships, the Government is also seeking approval from the Legislative Council for funding to install on-shore power supply facilities at the new Kai Tak Cruise Terminal.

1.3 Cruise industry and the new Kai Tak Cruise Terminal

In Hong Kong, there are local cruises and international cruises. Local cruises are regular, home-based casino cruises that offer one-night high sea service every day or even twice a day. International cruises are passenger carriers that stop over in Hong Kong as one of the many ports they visit in the entire voyage.
Decision made to build a new cruise terminal

From 1999 to 2005, total cruise passenger throughout in Hong Kong increased by over 50% to 2.15 million, including local residents and international passengers. In view of the growing Asian cruise market, an untapped source of passengers from Mainland China, plans by the world’s largest cruise operators to use Hong Kong as their homeport, and countered by the limited facilities at Ocean Terminal to meet future market demand, the Government decided in 2006 to develop a new cruise terminal on the former runway at Kai Tak. The first berth is scheduled to open in June this year, with the second berth becoming ready next year.

Economic benefits are attractive ...

It is anticipated that the new cruise terminal will help strengthen Hong Kong’s position as a cruise hub in Asia, which will in turn bring direct economic benefits to Hong Kong. Besides, the new facilities will also create job opportunities.

... but air quality will suffer and so will the people

However, there will be adverse impacts on air quality as a result of an increase in the number of cruise ships attracted to the new cruise terminal and to Hong Kong. It is typical for cruise ships to have very high at-berth power consumption. When the vessels are at berth, the main engine will usually be switched off. Auxiliary engines and boilers will be kept on to provide power and heating for passengers and crews. Since most cruise ships are burning bunker fuel with high sulphur content to provide power and heat, air pollutants emitted from equipment such as auxiliary engines and boilers will be extremely high in quantity.

Due to the proximity of the new cruise terminal to the population, people are concerned that cruise ship emissions will be blown into neighbouring districts in a downwind location, depending on season and wind direction. Local air quality will be affected, and so will the well-being of the local residents.
Cruise Ship Emissions

2.1 2007 emissions

In 2007, there were 3,562 cruise ship arrivals in Hong Kong. It was estimated that 1,145 tonnes of SO\textsubscript{2}, 1,598 tonnes of NO\textsubscript{x} and 132 tonnes of PM\textsubscript{10} were emitted from these vessels in Hong Kong waters.\textsuperscript{12} Figure 1 shows that a substantial portion of cruise ship emissions were produced at berth. It is due to the high power demand even when a cruise ship is moored, as explained in section 1.3.

![Figure 1: Cruise emissions by operation mode, 2007\textsuperscript{13}](image)

Ocean Terminal and the government buoys in Victoria Harbour near Hung Hom and Kowloon Bay are emission hotspots In terms of the spatial distribution of cruise ship emissions, it is observed that (a) Ocean Terminal and the government mooring buoys east of Hung Hom and south of Kowloon Bay are two major emission hotspots; (b) the fairways in Victoria Harbour (Central Fairway, Hung Hom Fairway and Eastern Fairway) and Tathong Channel east of Lei Yue Mun are the main corridors for cruise ship movements, and the emission level is also very high; and (c) the southeastern part of Hong Kong waters is an area of heavy cruise traffic and hence cruise emissions, as it is the main entrance/exit point for cruise ships to and from open sea (Figure 2).
Zooming in on the two major emission hotspots, Ocean Terminal is a regular berthing location for one or two home-based cruise ships and the preferred location for almost all the international cruise ships that visit Hong Kong (unless the ships are too big), whereas the government mooring area off Hung Hom and Kowloon Bay is a popular location for several home-based cruise ships. In 2007, for example, 266 and 323 tonnes of SO2 were emitted at Ocean Terminal and the government buoys in Victoria Harbour, respectively. That combined amount represents about 93% of all at-berth cruise emissions, and about 51% of total cruise emissions in Hong Kong waters.

<table>
<thead>
<tr>
<th>Location</th>
<th>Call Number</th>
<th>SO2</th>
<th>NOx</th>
<th>PM10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ocean Terminal</td>
<td>1,063</td>
<td>266</td>
<td>251</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(42%)</td>
<td>(30%)</td>
<td>(43%)</td>
</tr>
<tr>
<td>Government buoys in Victoria Harbour</td>
<td>1,877</td>
<td>323</td>
<td>542</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(51%)</td>
<td>(65%)</td>
<td>(51%)</td>
</tr>
<tr>
<td>Others</td>
<td>622</td>
<td>41</td>
<td>41</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(7%)</td>
<td>(5%)</td>
<td>(7%)</td>
</tr>
<tr>
<td>Total at-berth emissions</td>
<td>3,652</td>
<td>630</td>
<td>834</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100%)</td>
<td>(100%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>

2.2 2012 emissions

The number of cruise ship arrivals has dropped significantly in the last few years (Table 2). There were 2,185 cruise ship calls in 2012, compared to 3,652 in 2007, representing roughly a 40% drop. On the other hand, average berthing time per call increased from 9 hours in 2007 to over 13 hours in 2012.
Table 2: Cruise ship arrivals in Hong Kong, 2007 – 2012

<table>
<thead>
<tr>
<th>Year</th>
<th>Arrival Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>3,562</td>
</tr>
<tr>
<td>2008</td>
<td>2,910</td>
</tr>
<tr>
<td>2009</td>
<td>2,345</td>
</tr>
<tr>
<td>2010</td>
<td>2,134</td>
</tr>
<tr>
<td>2011</td>
<td>2,140</td>
</tr>
<tr>
<td>2012</td>
<td>2,185*</td>
</tr>
</tbody>
</table>

* preliminary figure

A bottom-up and activity-based approach to estimate cruise emissions

In order to estimate cruise ship emissions for 2012, a bottom-up, activity-based approach consistent with the study on marine vessels emission inventory in Hong Kong was used. Emissions per call were estimated based on (a) ship and engine information collected from Lloyd’s Register of Ships; (b) ship activity data gathered from Marine Department’s online vessel activity reports; and (c) other parameters for emission estimation such as fuel quality, load factors and emission factors adopted from the marine vessels emission inventory study.

Cruise emissions decreased in quantity in 2012, relative to 2007

It is estimated that in 2012, 867 tonnes of SO2, 1,287 tonnes of NOx and 97 tonnes of PM10 were emitted from cruise ships in Hong Kong waters. There is roughly a 20% to 25% drop in emissions between 2007 and 2012 (Table 3), reflecting the interplay between the drop in arrival numbers and the increase in average berthing time. Nevertheless, the pattern of emissions by operation mode in 2012 remains similar to that of 2007, with most emissions produced during hotelling (Figure 3).

Table 3: Cruise emission estimates (tonne), 2007 and 2012

<table>
<thead>
<tr>
<th>Year</th>
<th>SO2</th>
<th>NOx</th>
<th>PM10</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>1,145</td>
<td>1,598</td>
<td>132</td>
</tr>
<tr>
<td>2012</td>
<td>867</td>
<td>1,287</td>
<td>97</td>
</tr>
</tbody>
</table>

Figure 3: Cruise emissions by operation mode, 2012
Another important consideration is the spatial distribution of cruise ship emissions in 2012. Even though the number of cruise ship has reduced, major berthing locations and pattern of vessel movements remained very much unchanged. Ocean Terminal and the government mooring area outside Hung Hom and Kowloon Bay continued to be the focal points of cruise ship emissions.

In 2012, 271 and 158 tonnes of SO₂ were emitted at Ocean Terminal and the government buoys in Victoria Harbour, respectively. The combined amount of 429 tonnes represents about 84% of all at-berth cruise emissions, and about 50% of total cruise emissions in Hong Kong waters (Table 4).

<table>
<thead>
<tr>
<th>Location</th>
<th>Call Number</th>
<th>SO₂</th>
<th>NOₓ</th>
<th>PM₁₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ocean Terminal</td>
<td>437</td>
<td>271</td>
<td>246</td>
<td>27</td>
</tr>
<tr>
<td>Government buoys in Victoria Harbour</td>
<td>1,129</td>
<td>158</td>
<td>414</td>
<td>15</td>
</tr>
<tr>
<td>Others</td>
<td>619</td>
<td>79</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>Total at-berth emissions</td>
<td>2,185</td>
<td>509</td>
<td>761</td>
<td>51</td>
</tr>
</tbody>
</table>

2.3 Emissions at Kai Tak Cruise Terminal

Cruise terminal at Kai Tak will attract more cruise ships to Hong Kong

At the time of writing, it is confirmed that five cruise ships will be visiting Hong Kong from June to December 2013, and another eleven have been scheduled in the first four months of 2014 (Table 5). It is expected that Kai Tak Cruise Terminal will have more cruise ships after April 2014.

<table>
<thead>
<tr>
<th>Vessel Name</th>
<th>Estimated Arrival Time</th>
<th>Estimated Departure Time</th>
<th>Estimated Berthing Time (hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mariner of the Seas</td>
<td>12/06/2013 16:00</td>
<td>13/06/2013 16:00</td>
<td>24</td>
</tr>
<tr>
<td>Voyager of the Seas</td>
<td>15/10/2013 12:00</td>
<td>16/10/2013 07:00</td>
<td>19</td>
</tr>
<tr>
<td>Diamond Princess</td>
<td>16/10/2013 08:00</td>
<td>16/10/2013 19:00</td>
<td>11</td>
</tr>
<tr>
<td>Mariner of the Seas</td>
<td>05/11/2013 12:00</td>
<td>06/11/2013 01:00</td>
<td>13</td>
</tr>
<tr>
<td>Celebrity Millenium</td>
<td>20/12/2013 07:00</td>
<td>22/12/2013 20:00</td>
<td>61</td>
</tr>
<tr>
<td>MV Voyager</td>
<td>18/01/2014 07:00</td>
<td>20/01/2014 17:00</td>
<td>58</td>
</tr>
<tr>
<td>Celebrity Millenium</td>
<td>15/02/2014 07:00</td>
<td>17/02/2014 20:00</td>
<td>61</td>
</tr>
<tr>
<td>MV Balmoral</td>
<td>21/02/2014 12:00</td>
<td>22/02/2014 23:00</td>
<td>35</td>
</tr>
<tr>
<td>Mariner of the Seas</td>
<td>11/03/2014 19:00</td>
<td>12/03/2014 16:00</td>
<td>21</td>
</tr>
<tr>
<td>Celebrity Millenium</td>
<td>15/03/2014 07:00</td>
<td>17/03/2014 20:00</td>
<td>61</td>
</tr>
<tr>
<td>Diamond Princess</td>
<td>20/03/2014 08:00</td>
<td>20/03/2014 19:00</td>
<td>11</td>
</tr>
<tr>
<td>Seven Seas Voyager</td>
<td>29/03/2014 13:00</td>
<td>30/03/2014 18:00</td>
<td>29</td>
</tr>
<tr>
<td>Queen Mary 2</td>
<td>01/04/2014 08:00</td>
<td>02/04/2014 18:00</td>
<td>34</td>
</tr>
<tr>
<td>Diamond Princess</td>
<td>08/04/2014 07:00</td>
<td>08/04/2014 18:00</td>
<td>11</td>
</tr>
<tr>
<td>Celebrity Millenium</td>
<td>12/04/2014 07:00</td>
<td>13/04/2014 20:00</td>
<td>37</td>
</tr>
<tr>
<td>Diamond Princess</td>
<td>23/04/2014 08:00</td>
<td>23/04/2014 19:00</td>
<td>11</td>
</tr>
</tbody>
</table>
Projected emissions at Kai Tak is high due to bigger vessel size and longer stay.

Based on the ship and engine information collected for these vessels from Lloyd’s Register of Ships, as well as vessel activity information collected from published materials, it is estimated that the 16 vessel calls listed in Table 5 will contribute about 43 tonnes of SO$_2$, 44 tonnes of NO$_x$ and 5 tonnes of PM$_{10}$ in Hong Kong waters during their visit (Table 6). A further breakdown of emissions by operation mode shows that majority of emissions (about 86%) will be produced at berth while the vessels are hotelling (Figure 4). The proportion of at-berth emissions is higher than average because of the long berthing time at Kai Tak Cruise Terminal as shown in Table 5.

### Table 6: Cruise emission estimates (tonne) at Kai Tak Cruise Terminal, 2013 and 2014

<table>
<thead>
<tr>
<th>Year</th>
<th>SO$_2$</th>
<th>NO$_x$</th>
<th>PM$_{10}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013 (Jun – Dec)</td>
<td>13.1</td>
<td>13.4</td>
<td>1.4</td>
</tr>
<tr>
<td>2014 (Jan – Apr)</td>
<td>29.6</td>
<td>30.4</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>42.6</strong></td>
<td><strong>43.8</strong></td>
<td><strong>4.7</strong></td>
</tr>
</tbody>
</table>

### Figure 4: Emissions by operation mode, vessels visiting Kai Tak Cruise Terminal from June 2013 to April 2014

Air quality in neighbouring communities will be affected most in summer.

During summer months, when the prevailing wind is coming from the southwest or the south, it is likely that cruise emissions produced at Kai Tak Cruise Terminal will be blown towards the Kai Tak development site to the north and Kwun Tong to the east.
Cruise Emissions Control Options

In the previous section, it is estimated that about 429 tonnes of SO₂ were emitted from the two major berthing locations for cruise ships in 2012, Ocean Terminal and the government buoys in Victoria Harbour near Hung Hom and Kowloon Bay. That amount alone was already 50% more than the SO₂ emitted from the entire road transport sector (286 tonnes) in 2010.

The new Kai Tak Cruise Terminal and its first 16 visiting vessels will add another 42.6 tonnes of SO₂, as well as other air pollutants, after its opening in June this year. Once the terminal is operating close to its full capacity, cruise ship emissions from this location will scale up very quickly. It will become a new health threat to the people living and working in neighbouring communities.

Public concern over air quality and health has triggered calls from different sectors of society for the cruise industry to clean up as soon as possible. In this section, several control options will be discussed in some details.

3.1 At-berth fuel switching

One of the main problems with all marine vessels is the burning of bunker fuel to provide engine power and heat, and in this respect cruise ships are no exception. Like other vessel types, cruise ships are allowed to burn bunker fuel with sulphur content of not more than 3.5% under the regulation stipulated by the International Maritime Organization (IMO), except in IMO approved emission control areas (ECAs) or in jurisdictions where regulations on marine fuel quality and emission standards are in force. At present, there is no such regulation in Hong Kong, or in other parts of Asia. Without any mandatory requirement, cruise ships will continue to burn bunker fuel to save costs.

There are exceptions in Hong Kong. First, it is understood that some of the home-based cruise ships have been using low sulphur distillate fuel of 0.5% sulphur content for a few years already, as a means to reduce black smoke. Second, Crystal Cruises and Prestige Cruise Holdings had signed up for FWC in 2011, and pledged to switch to clean fuel while at berth in Hong Kong. While the two companies only had a handful of calls in 2011 and 2012, their participation in FWC is an important statement from the cruise industry about the role they could play in emission reduction.

Given the Government’s plan to regulate at-berth fuel switching in Hong Kong and having rolled out an incentive scheme, it becomes a readily available option in the short term for the cruise industry to clean up. Besides, fuel switching is a proven emission reduction measure for ships. For example, thousands of fuel switches were carried out each year under FWC in Hong Kong since 2011, the majority being container vessels, and there have been no reporting of technical problems. Similarly in California, all OGVs have been required to use low sulphur fuel since 2009, and no incident was reported from cruise ships.
More importantly, the major advantage associated with fuel switching is the potential to substantially reduce SO$_2$ and PM$_{10}$ emissions swiftly, as long as low sulphur fuel is available and the extra cost is paid for.

For demonstration purpose, it is estimated that if all the cruise ships agree to switch to 0.5% sulphur fuel while berthing at the new Kai Tak Cruise Terminal between June 2013 and April 2014, at-berth SO$_2$ and PM$_{10}$ emissions will be reduced by about 83% and 78% during that period, respectively. However, NO$_x$ emissions will only be reduced by about 5% (Table 7).

### Table 7: Cruise emission reduction potential of at-berth fuel switching (tonne) at Kai Tak Cruise Terminal, 2013 and 2014

<table>
<thead>
<tr>
<th></th>
<th>SO$_2$ Before fuel switch</th>
<th>SO$_2$ After fuel switch</th>
<th>NO$_x$ Before fuel switch</th>
<th>NO$_x$ After fuel switch</th>
<th>PM$_{10}$ Before fuel switch</th>
<th>PM$_{10}$ After fuel switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>At berth</td>
<td>36.7</td>
<td>6.3</td>
<td>38.0</td>
<td>35.9</td>
<td>4.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Total</td>
<td>42.6</td>
<td>12.2</td>
<td>43.8</td>
<td>41.8</td>
<td>4.7</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Similarly, if all cruise ships visited Hong Kong in 2012 were to switch to 0.5% sulphur fuel while at berth, at-berth SO$_2$, NO$_x$ and PM$_{10}$ emissions would be cut by approximately 71%, 3% and 63%, respectively (Table 8). The emission reduction benefits are less impressive than the last example in terms of percentage drop because some home-based cruise ships are already using low sulphur fuel, as explained in section 3.1.

### Table 8: Cruise emission reduction potential of at-berth fuel switching (tonne) in Hong Kong, 2012

<table>
<thead>
<tr>
<th></th>
<th>SO$_2$ Before fuel switch</th>
<th>SO$_2$ After fuel switch</th>
<th>NO$_x$ Before fuel switch</th>
<th>NO$_x$ After fuel switch</th>
<th>PM$_{10}$ Before fuel switch</th>
<th>PM$_{10}$ After fuel switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>At berth</td>
<td>508.7</td>
<td>147.6</td>
<td>760.7</td>
<td>741.7</td>
<td>51.2</td>
<td>19.0</td>
</tr>
<tr>
<td>Total</td>
<td>867.0</td>
<td>505.9</td>
<td>1,286.9</td>
<td>1,267.9</td>
<td>97.1</td>
<td>65.0</td>
</tr>
</tbody>
</table>

There are also potential health benefits to society. Reducing cruise ship emissions from the major berthing locations, including the new Kai Tak Cruise Terminal, is important for the protection of public health. These terminals are located at the heart of the city, and close to Hong Kong’s population and business centres. Improved air quality will bring along medical and other cost savings to society.
3.2 On-shore power

While at-berth fuel switching will already reduce SO\textsubscript{2} and PM\textsubscript{10} emissions significantly, the use of on-shore power by vessels while they are berthing will reduce at-berth ship emission further. Once the ships are connected to the shore-side power grid, no air pollutants will be emitted directly from the vessels. Of course, there will be a transfer of air pollution (and greenhouse gas emission too) from the terminals to the power plants. In this respect, whether the promotion of on-shore power for vessels would bring the greatest net environmental benefit to Hong Kong warrants a separate study, and is beyond the scope of this paper.

Kai Tak is in a better position to have on-shore power

At present, Kai Tak Cruise Terminal has the greatest potential to install on-shore power facilities and to attract cruise ships to plugging into the grid. The Government is planning to secure funding to install the on-shore power supply facilities, but may take at least a couple of years to have on-shore power ready for use.

Doing the same at Ocean Terminal will be less straightforward

The situation at Ocean Terminal, as in other in-use terminals, will be more complex. First, looking for shore-side space to retrofit power supply facilities could be a challenge. Second, it remains to be determined by the power company whether the existing power sub-station could accommodate additional power demand incurred by on-shore power supply. Third, Ocean Terminal is operated by Wharf Holdings Limited under a lease agreement with the Government, including the payment of an annual rent. Any plan to provide on-shore power supply at Ocean Terminal would become a business decision by the operator, as much as an air quality management decision by the Government.

Other factors will also determine the use of on-shore power

The provision of on-shore power supply at the terminals is a necessary but not sufficient condition to make on-shore power an attractive option for cruise ships. There are other important factors that need to be considered.

First, the level of power requirement and the length of stay of a vessel is a major consideration. For cruise ships, a lot of power is required while at berth, and very often cruise ships will berth for an extended period of time (more than just a few hours, and sometime a few days). It makes cruise ships a fitting candidate to use on-shore power.

Second, cost comparison between using marine fuel (bunker or distillate fuel) for the auxiliary engines and connecting to the on-shore power grid is to many people the deal-breaker. However, this is port-specific and even ship-specific, and it is therefore important for Hong Kong to carry out its own assessment on the cost-effectiveness of cruise ships using on-shore power. How much will be charged for on-shore power, and how much the ships will be paying to make them capable of using on-shore power in the first place?

Third, one question the ship owners may ask is how many ports are currently providing on-shore power to cruise ships, and how many of those ports are also on their sailing schedule? Unfortunately, most of the on-shore power systems at present have been developed in North America and Europe.\textsuperscript{20} Cruise owners operating in the Asian market could be reluctant to invest in on-board equipment for on-shore power if Hong Kong is the only port in this
region that promotes on-shore power use for cruise ships in the next few years. Regional collaboration could be important here to drive change.

Last, the potential for cost savings may drive some cruise owners to add vessels with on-shore power capability to their fleet. More effectively still, regulations like those enforced in California to reduce at-berth emissions will prompt cruise owners and operators to look for alternative options. For examples, Holland America Line, Princess Cruises, and Norwegian Cruise Line have been retrofitting and operating cruise ships in North America that are equipped with on-shore power capability. Costa Cruise is another company with ships that can plug into shore side electricity supply.

### 3.3 Other options

Apart from at-berth fuel switching and on-shore power, there are other control options that would reduce cruise ship emissions.

At the moment, vessel speed limits are in force in Victoria Harbour, with maximum speed for vessels over 60 metres long set at 8 knots and 10 knots in the western and eastern portion of Victoria Harbour, respectively. Cruise ships will comply with the speed limits, but they will speed up once beyond the speed limit zones. In other words, there is little scope to further tighten the speed of cruise ships in Victoria Harbour. The real potential to implement vessel speed reduction for cruise ships to have an impact would be to expand the speed limit zones to include say Tathong Channel and the southeastern part of Hong Kong waters.

Scrubbers have been often brought up as an alternative clean-up option for vessels. Other innovative solutions are coming up from time to time, and it becomes apparent that a technology-neutral emission reduction standard and strategy would be the best way to go. In short, it is most important for the Government to set emission standards first that would demand environmental improvement and protect public health and the time line to achieve them, and then leave it to the industry to decide the best approach or the best combination of solutions to meet those standards and requirements. A technology-neutral approach looks even more practical as we are facing the challenge of reducing not just one but different air pollutants and greenhouse gases, which demands more than one trick to address the issue.
Conclusion

Scientific evidence is adding up

This paper makes an attempt to estimate cruise ship emissions in Hong Kong in 2012, as well as to predict emissions produced by the cruise ships that are planning to berth at the new Kai Tak Cruise Terminal in the latter half of 2013 and in early 2014. Results show that at-berth emissions at Ocean Terminal and in Victoria Harbour near Hung Hom and Kowloon Bay represent a significant portion of cruise ship emissions in Hong Kong. At-berth emissions expected at the new Kai Tak Cruise Terminal will add to the problem. For the benefit of air quality and people’s health, swift actions should be taken to reduce cruise ship emissions.

Need to balance tourism, economic growth and environmental protection

It is not to suggest that Hong Kong should not develop its tourism and cruise industry. It is plain to see that Hong Kong possesses a lot of qualities to become Asia’s premier cruise hub, and with that Hong Kong’s economy will reap the benefits. To become a liveable city, however, Hong Kong’s real challenge is to grow smartly without compromising our environmental quality. So the question is: can we minimise the impact on air quality as we develop our cruise industry in Hong Kong?

The answer is a ‘yes’. As illustrated in this paper, there are proven and effective control options suitable for Hong Kong to reduce cruise ship emissions, and these are measures consistent with international practice.

The key is partnership at different levels and among various stakeholders

The key to making progress is not just about solutions. It is also about partnership, and how all the main stakeholders can work together to reduce ship emissions and protect public health. Such partnership would involve collaboration among the public and private sectors and civil society groups via a common platform. Even within the public sector, multi-bureaux and cross-departmental co-operation would be crucial to drive policy change.

Government agencies, cruise ship companies and operators all have a role to play

To move forward together, it is important for government agencies such as Tourism Commission, Transport and Housing Bureau, Environment Bureau, Marine Department, and Environmental Protection Department to:

- Expedite the regulation of at-berth fuel switching in Hong Kong;
- Expedite the installation of on-shore power supply at the Kai Tak Cruise Terminal;
- Explore the possibility of providing on-shore power supply at Ocean Terminal with Wharf Holdings Limited;
- Promote the use of on-shore power once installation is completed through incentives, and regulations;
- Explore with the cruise industry other control options to reduce emissions, such as vessel speed reduction; and
- Formulate a technology-neutral ship emissions control framework in the long term to encourage innovative solutions.
Cruise ship companies should be encouraged to:

- Sign up for FWC as soon as possible and commit vessels to at-berth fuel switching in Hong Kong;
- To register for the Government’s incentive scheme and apply for the 50% reduction in port facility and light dues as a means to recover part of the extra fuel costs; and
- To review corporate position with respect to on-shore power and to prepare long-term strategies for cutting emissions.

Cruise terminal owners and operators could:

- Promote at-berth fuel switching to business partners through incentives and recognition;
- Explore the possibility of adding on-shore power supply to terminal facilities; and
- Promote the use of on-shore power to business partners once installation is completed.
Endnotes

1. Hong Kong Air Pollutant Emission Inventory
   (accessed 2 March 2013).


   Report submitted to Environmental Protection Department, Hong Kong SAR Government,
   (accessed 2 March 2013).

4. Ibid.

5. Ibid.


8. Environmental Protection Department, “Incentive scheme for ocean going vessels to switch fuel at berth”, Paper CB(1) 1949/11-12(05) submitted to Legislative Council Panel on Environmental Affairs for discussion on 28 May 2012,


10. Ibid.


12. See note 3.

13. Ibid.

14. Ibid.

15. Ibid.

16. Preliminary estimation based on data collected from Marine Department’s vessel activity reports.

17. For 2007, see note 3; for 2008 to 2011, Marine Department, [various years] Port of Hong Kong Statistical Tables; for 2012, preliminary figure from

18. See note 3.

19. Kai Tak Cruise Terminal Cruise Schedule (June 2013 to April 2014),

20. World Ports Climate Initiative, Ports using Onshore Power Supply (OPS),


22. California Air Resources Board, (2007) Regulations to reduce emissions from diesel auxiliary engines on ocean-going vessels while at-berth at a California Port,

23. ship-technology.com, [Costa Fascinosa Concordia-Class Cruise Liner, Italy],